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ABSTRACT

A prescriptive theory for learning which delivers prescriptions for designing prototypes of instructional materials with different knowledge structures, the Elaboration Theory of Instruction (ETI) is based on important principles and theories of learning and instruction. This paper reports three experiments which tested ETI. The first experiment was concerned with the effect of ETI and individual differences (prior knowledge, cognitive style, anxiety, motivation, learning strategy, and attitude). Subjects were 18- to 20-year-old students in a middle technical school. The results confirmed the hypothesis that the strong structured approach of the ETI is effective for students who need external cues in the text. The second experiment, which was conducted with 14- to 15-year-old high school students, focused on the effects of synthesizers in text processing. Few differences were found between the conditions, but there was a tendency for students in the general-to-detailed sequence to perform better. The third experiment explored the possibility of using ETI for adaptive text presentation involving learner versus text control of the learning process. Subjects were undergraduate education students. It was found that students in the learner control condition retained information better and longer. The need for more research on the amount of training in the use of learner control to optimize performance is noted. A list of 32 references and 6 data tables are attached. (DJR)

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DESIGNING INSTRUCTIONAL TEXTS:

INTERACTION BETWEEN TEXT AND LEARNER

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DESIGNING INSTRUCTIONAL TEXTS:

INTERACTION BETWEEN TEXT AND LEARNER

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On the basis of the subsumption theory of Ausubel and the schema theory, the Elaboration Theory of Instruction (ETI) gives prescriptions for structuring subject matter in such a way as to facilitate learner control. This means control over selection and sequencing of ideas as well as control over frequency and timing of such stragety components as synthesizers, summarizers and reviews. The subject matter is sequenced from general to detailed. At the Syracuse University (Reigeluth) and at the Twente University (Beukhof) this prescriptive technology of text is used for some extensive research and field tests. In this article three experiments are reported in which the ETI (or a part of the ETI) is tested. In experiment 1 the results partly confirm the hypotheses: studens perform better and follow other learning strategies with an ETI-text.

Individual differences and the ETI are examined. Prior knowledge is the major declarative variable. Experiment 2 shows that graphic synthesizers (i.e., a diagram with the major concepts) facilitate learning. The results of experiment 3 about learner- versus program control show a tendency that students in the learner control condition are retaining information better and longer.
These results about learning processes and learning outcomes are necessary for designing instruction, based on the ETI. Future research will go into Computer-Based-Instruction which gives us more insight into the interaction between the text and the learner.

INTRODUCTION

In schooling the independent studying of text is an important learning activity. In learning from texts, three processes are interrelated: understanding the information presented in the text, retaining that information and: using that information. The task in learning from text is - in the first place - constructing a semantical representation. Support in constructing a representation can be given by writing the text in such a way that it agrees as well as possible with the way in which the knowledge of the learner is organized.
In research of textprocessing there is a growing interest in learner-generated textprocessing, which contains the active role of the learner in the interaction between the learner's knowledge structures and the structure of the information content in the instructional materials.
Interest in adapting instructional methodology to accommodate individual learner characteristics has been stimulated by the recent popularity of Aptitude Treatment Interaction (A.T.I.) research. A.T.I., however, has failed to provide an adequate conceptual or empirical basis for a prescriptive set of adaptive instructional designs (Jonassen, 1982; Beukhof, 1984). Based upon cognitive task analysis and content analysis, the search for

content-treatment interactions and their applications to instructional development make adaptive designs more feasible, efficient, and consistent.

Instructional design as a discipline is concerned with producing knowledge about optimal "blueprints", e.g. knowledge about diverse methods of instruction, optimal combinations of methods (i.e., whole models), and situations in which each of those instructional models is optimal (Reigeluth, 1983). Instructional methods variables for instructional design are classified as three types: (1) organizational; (2) delivery (media, teachers), and (3) management (planning). The organizational strategy variables are elemental methods for organizing the subject-matter content that has been selected for instruction: On the microlevel for a single idea (i.e. a single concept, principle etc. - see the Component Display Theory, Merrill, 1983), on the macrolevel for related ideas (such as sequencing, synthesizing, and summarizing - previewing and reviewing - the ideas that are taught - see the Elaboration Theory of Instruction, Reigeluth, 1983).

The Elaboration Theory of Instruction (ETI) is a prescriptive theory for learning which delivers prescriptions for designing prototypes of instructional materials with different knowledge structures, and is based on important principles and theories of learning and instruction. On the basis of Ausubel's subsumption theory (Ausubel, 1963) and the schema theory of Norman & Rumelhart (1975) the ETI gives prescriptions for structuring subject matter in such a way as to facilitate learner control. This means control over selection and sequencing of ideas as well as control over frequency and timing of such strategy components as synthesizers and reviews. The basic idea of the ETI is how to structure or organize subject matters. The ETI follows a top-down approach and follows the cycle: elaborate-synthesize-elaborate-synthesize. To increase long term retention, the instruction begins with an overview that epitomized the content rather than summarizes it. Than gradually elaborate on each aspect of that overview (Reigeluth, 1983; Beukhof, 1983). To the subject matter a number of instructional aids are added which are meant to let the storage and processing of information take place more effectively because they explain the structure of the subject matter by repetition of important concepts and explication of

important relationships. ETI prescribes that a text should start with an epitome, in which the most important elements of the subject matter are introduced in their common coherence and illustrated with examples. It is hypothesized that when structural relations are taught explicitly, learning will be more meaningful, leading to greater retention and transfer. After this epitome the elaborations follow from general to specific. It is hypothesized to make the learning more meaningful and less rote by effecting acquisition on the application level rather than on the memorization level. This is expected to result in easier and more enjoyable learning and better retention.

Elaborations are completed subject matter parts. Every elaboration is followed by three instructional aids, namely: (1) a "summarizer" for systematically review, so as to help prevent forgetting; (2) a "synthesizer" to periodically interrelate and integrate the individual ideas to have been taught. Synthesizers have several instructional functions, they: (a) provide students with that valuable kind of knowledge; (b) facilitate a deeper understanding of the individual ideas through comparison and contrast; (c) increase the meaningfulness and motivational effect of the new knowledge by showing how it fits within a larger picture, and (d) increase retention by creating additional links between the new knowledge and between the new knowledge and the learner's relevant prior knowledge.

Reigeluth (1983) gives the other strategy-components of the ETI: the eleborative sequence, the learner prerequisite sequence, the use of analogies, and cognitive strategies, and the learner format.

ETI is concerned with the analysis of the subject matter and there is an increasing emphasis on the cognitive structure as well as subject matter structure by introducing a working analogy or model at the onset of instruction (Merrill, Kowallis & Wilson, 1981). The subject matter is a set of content constructs that are grouped together in the basis of a single pervasive relationship among themselves. These content contructs are facts, concepts, procedures and principles, the relationships between multiple comprise content structures, or list, taxonomies, parts hierarchies, procedures, and models.

The ETI is likely to be valid only for instruction on a fairly large amount of sybject matter (e.g., for instruction on many

interrelated constructs).

The Component Display Theory (Merril, 1983) organizes instruction on a single concept or principle. ETI and the Component Display Theory are together a technology of text. Both theories are integrative theories, based upon many other models and theories. In the field of instructional design there is a need to use and integrate all the available knowledge about learning and instruction. Bloom (1984) states:

"It is likely that a combination of advance organizers at the beginning of a new topic, further organizational aids during the chapter or unit, as well as appropriate questions, summaries, or other organizational aids at the end of the units may have a substantial effect on the student's learning of that chapter (....) need for careful search of the new curricula and textbooks to determine which ones are more effective and to determine what characteristics make them more effective than others"

Mayer (1981) has formulated criticism of the ETI: (1) Vagueness: lack of specificity of terms; (2) Empirical tests: need for empirical support of aspects of the theory; (3) ETI is a technology rather than a theory: it gives a procedure for constructing texts, but it does not give an explanation for the cause of possible possitive effects; we need to know how and why elaboration techniques work! (4) ETI focuses more on an analysis of the stimulus than on an analysis of the learner's information processes.

He gives also an agenda for work on the ETI:

- description of the information processing variables (attention, integration);
- description of the predicted learning outcomes, measured in a quantitative and qualitatieve way;
- description of the features of epitomes, synthesizers etc.

The ETI have undergone very limited field testing and no systematic integrated research. There is a continuing need to integrate more of our expanding knowledge about instructional processes (Merril, Wilson & Kelety, 1981; Beukhof & Pieters, 1982).

Theoretical support for the validity of the ETI comes from several sources, i.e., Norman's web-learning model privides simular parallels with the ETI (Norman, 1978). Future research will be concerned with a cognitive instructional design theory

based upon a theory of the subject matter and upon a theory of information processing (Gagne, 1985).
At the Syracuse University (Reigeluth) and at the Twente University of Technology in the Netherlands (Beukhof) the ETI is used for some extensive research and field tests to demonstrate strength and weakness of the theory.
In this paper we report three experiments in which (parts of) the ETI are tested:
1. The ETI and individual differences;
2. the effects of parts of the ETI (e.g., synthesizers) on learning outcomes;
3. the ETI and learner versus programcontrol.
The first two experiments will be reported very short by (see also Beukhof, in preparation).

EXPERIMENTS

Experiment 1: The ETI and individual differences.

Theoretical background.

The knowledge a person already prosesses has a potent influence on what he or she will learn and remember for exposure to discourse (Anderson, 1978). The relative contributions of the reader's knowledge structure and the text structure is dependent on the nature of text, the purpose for reading, and the ability of the reader. Comprehension is best represented as an interaction of content in text and the reader's prior knowledge.

Aim

In this experiment we were interested in the effects of ETI and individual differences. The major individual differences in textprocessing, related to the nature of the task, namely: a text structured according to the ETI with an epitome, synthesizers, summarizers, and reviews, are: prior knowledge (about the subject matter), cognitive style, anxiety, motivation, learning strategy, and attitude.

Research methods and techniques

It was an ATI-research with two treatments: (1) the ETI-text, and

(2) a "common" text without the ETI-instructional components. Students were tested for individual differences. After the instruction: posttest, retentiontest and a self-report questionnaire.
Data-analyses: regression and co-variance analysis; cluster analysis.

Data source
Subjects were students from a Middle Technical School (age: 18-20). The subject matter was a part of the course "Electronics", (Solder). The major structure of the subject matter was a taxonomy with a supporting procedural structure.

The major results
- The ETI-students performed better on the posttest and the retentiontest.

INSERT TABLE 1 ABOUT HERE

- Prior knowledge, deductive reasoning and anxiety were the most important declarative variables;
- Studens with an ETI-text followed a more learner controlled strategy;
- Synthesizers and summarizers were necessary for meaningful learning;
- The ETI did not lead to more subject-generated activities, as making notes, schema's etc.;
- Students preferred an ETI-text.

Conclusion
In this experiment the ETI was successful mostly for students with a low level of prior knowledge. Students with a high score on the test "Deductive reasoning" performed better on the ETI-text; students with a high level of failure-anxiety also performed better. These results confirm our hypotheses that the strong structured approach of the ETI is effective for students who need external cues in the text (Jonassen, 1983). For

instructional designers it would be useful to design adaptive and flexible instructional texts, with a great degree of learner control (Merrill, 1983) Reigeluth, 1983, see also experiment 3 in this paper).

Experiment 2: The effects of synthesizers on learning outcomes

Theoretical background

Syntesizers refers to outlining to the student the major relationships between the ideas expressed in a given topic. This is a critical part of the instructional process in that much of learning involves the integration of isolated concepts into an unified message. It shows the logical structure of knowledge, in an attempt to create an isomorphic psychological structure for meaningfulness and instruction (Reigeluth & Stein, 1983). Synthesizers are essential parts of the ETI and familiar with research on "advance organizers" (Ausubel, 1963; Mayer, 1982; Patrick & Evans, 1983) and "networking", "schematizing" and "mapping" (see a.o. Barron & Schwarz, 1984; Geva, 1981).

Aim

This experiment was basis upon three experiments of Reigeluth c.s. (Frey & Reigeluth, 1981; Carson & Reigeluth, 1983; McLean, Kay Yeh & Reigeluth, 1983). It is partly a replication of the last two experiments together. The major research question was: What are the effects of synthesizers in textprocessing?

Research methods and techniques

There were 14 treatments: sequence: general-detailed and detailed-general; synthesizer: before instruction and after instruction; synthesizer: verbal, graphic, graphic/visual and no synthesizer. Students were tested with a posttest and a retentiontest.

Data source

Subjects were students from ten sucundary schools (age 14-15). The subject matter was a course on the Micro computersystem. The major structure of the subject matter was a taxonomy.

Results and conclusions

There were a few differences between the conditions (no signifant differences were found) but there was a tendency that in the general-to-detailed sequence students performed better. Synthesizers (verbal and graphic) were effective, mostly graphic synthesizers facilited learning.

INSERT TABLE 2A,B,C and D ABOUT HERE

It was found too that students did not interpret and use the synthesizers very well. They only looked at the synthesizers but they could not integrate them into their learning strategies. In this experimentor-provided activity the learner had not an active role and could not undertake student-provided activities (Jonassen, 1985). Training in how to use and interpret synthesizers is important for future research on (parts of the) ETI.

Experiment 3: the ETI and learner-versus program control.

Theoretical background

Macroprocesses may be interest to instructional psychologists (Tobias, 1982). When and how often do students review previous learned material? When, and how often do students stop to take notes or otherwise summerize what they have learned? In those cases where objectives, summarizers, synthesizers, epitomes are provided for the students, what do students do? Do they review previous learned material, and if so which previous material? If material is reviewed, do students spend equal amounts of time skimming over every part of it, or do they search for a particular set of materials? Do students consult the objectives frequently, while studying, or look at them only once? Do they skim for context related to the objectives and ignore other

material.

"We know very little about whether different instructional methods lead students to engage in different macroprocesses, or whether they engage in such processes with different frequencies. Only when data become available pertaining to the processes students use during instruction, will instructional researchers be able to talk intelligently about the effects of different methods (Tobias, 1982).

In the ETI-model there are possibilities for variations (Reigeluth, 1983); the first concers the type of organization selected for a particular course of curriculum, the second concerns the degree of adaptability of the sequencing to the individual learner and the degree of control given learner over the sequencing in the "zooming-in" process (including the development and use of metacognition models with which the learner approaches learning tasks). Learner control refers to the freedom the learner has to take command of the selection and sequencing of (1) the content to be learned; (2) the rate at which he or she will learn (pace control), (3) a particular instructional strategy components he or she select and the order in which they are used (display control) and (4) the particular cognitive strategies the learner employs when interacting with the instruction (conscious cognitive control). For ETI there are possibilities for (1), (2) en (4).

With respect to learner control over **content**, elaborative sequencing makes it possible for a learner to pick that aspect of the epitome - or of any other lesson - that interest him or her the most and to study it next.

Only a simple - to - complex sequence can allow a learner to make an **informed** decision about the selection of content.

The learner can then continue to select more detail in that area, or he or she can return to an earlier lesson and pick up a different aspect of it for further eleboration.

Aside from the selection and sequencing of content, learner control can also be provided for the selection and sequencing of strategy components. The learner could be given greater freedom to decide when and if he or she wants to view a summarizer or a synthesizer or an analogy. The learner could also be given the freedom to select the cognitive strategies that are most apropriate an

useful for him or her at that particular point in the instruction.
Clearly separated and labeled instructional components or cognitive-strategy activators make it easier for the learner to select and sequence these components according to his or her personal needs and interest, including the selective review and study of summarizers and synthesizers.
Learner control and text (program) control are dimensions (Jonassen, 1985) and it is useful to talk about the degree of learner control or text control.

degree of learner control	degree of text control
- learner-generated	- text (instructor) provided
- individually-constructed knowledge	- text (instructor) controlled
- constructive	- reproductive
- intrinsic motivation	- extrinsic motivation
- personally relevant	- content relevant
- stimulates metacognition	supplants metacognition
- activates appropriate knowledge structures	- identifies/supplants knowledge structure
- learner-referenced	- objective-referenced

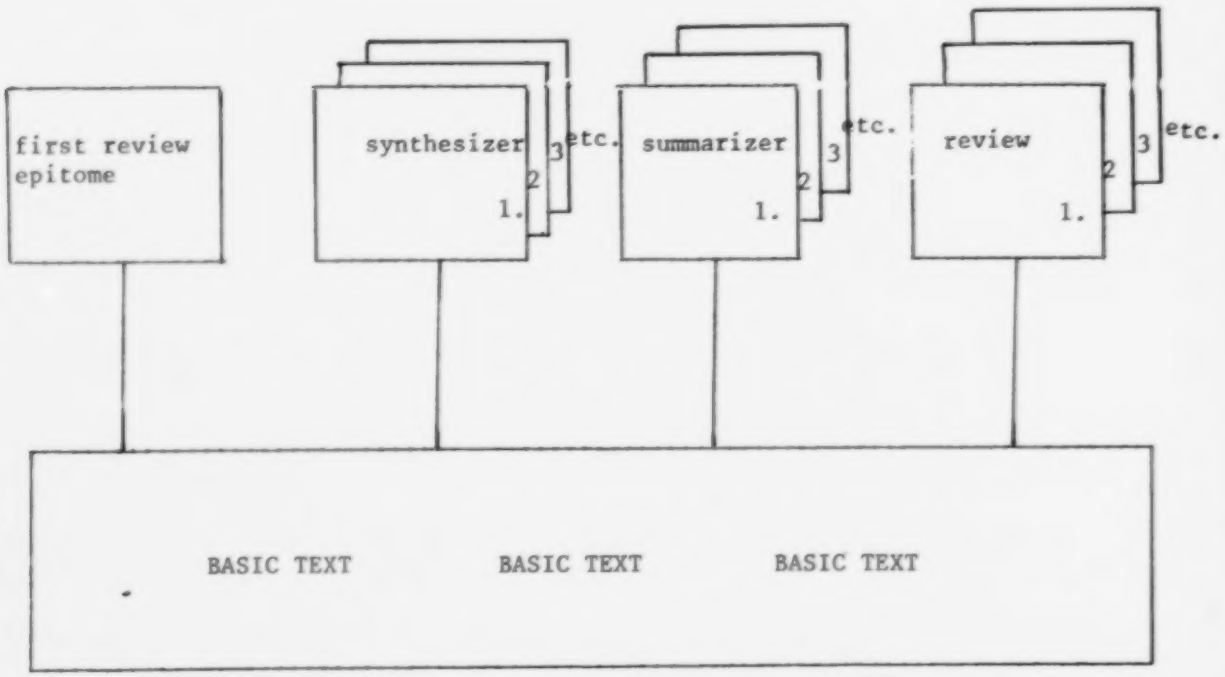
Research on learner control, mostly in Computer Based Learning has contradictory findings and equivocal terminology but students do select patterns of learning when given the choice and some patterns may be more succesful than others. Flynn Sasscer & Moore (1985) found no evidence that students used a pattern consistent throughout the lesson. Hannafin (1984) states that more able students perform better under learner control; less capable students perform best under lesson control

In this study the question is: is it possible to use the ETI for

adaptive textpresentation. Our expectation is that students can perform better with flexibility in textpresentation ("learner control") when using other learning strategies.

Subjects, materials, method and procedure

Twenty-four students of the Department of Education (third year) took part in this study. These students were divided into two groups: condition I: learner control; condition II: text(program)control. There were no differences in prior knowledge (mean score) between the conditions.
The study material was a text about the subject matter "solder" (the basic text) and provided with the text aids: epitome, synthesizers, reviews, and summarizers (the options). The text consisted of a conceptual and a procedural subjectmatter structure (kinds of "solder" and "how to solder"). The basic text and the options were given to the students separately in two booklets.



Before studying text, students got instructions how to study and how to use the options. In the program controlled condition there was a fixed sequence: the students had to follow: epitome - text - synthesizer - summarizer - text - synthesizer 2, summarizer 2 - review 1 - text - etc. In the learner - controlled condition students were free to select either the options or parts of the basic text. The study-time was 80 minutes. The study-sessions were video-taped for analysing the study-behaviour. As effect measurements a multiple choice test and an open essay test were carried out immediately after the text studying.
Three weeks later two parallel versions were taken. These criterial measurements are linked to the kind of learning processing and the nature of het instructional tasks: multiple choice: learning facts, concepts, essay questions asked more about synthesizers, summarizers and pre- and reviews.

Information about the text learning strategies were also obtained by a self-report questionnaire (Schmeck, Ribich, Ramanaiah, 1977)

RESULTS AND DISCUSSION

The results are presented in Table 3.

INSERT TABLE 3 ABOUT HERE

The results did not confirm the hypothesis directly: students in the learner Controlled (L.C.) condition did not significantly perform better on the criterial measurements than students in de Program Controlled (P.C.) condition.
But there was a tendency that students in the L.C. condition are performing better and retaining the information better (see the difference between posttest and retentiontest in both conditions). Students in het P.C.-condition were making more

notes with facts, concepts and relations between concepts, because they had not the flexibility using the options every time they needed. Students in the L.C.-condition were using more 'strategic knowledge', i.e., time for the options, mostly for the epitome and the summarizers.
The correlation between 'prior knowledge' and 'time-on-options' in the L.C.-condition was r=.56 (p=.059): more capable students were using the options more frequently than less capable students.The analyses of the video-taped lessons showed a great variety in learning strategies in the L.C.-condition.

The following activities could be observed with the subjects who were in the L.C.- condition:
(1) Structuring the text: on the basis of an epitome they searched in the text for paragraphs, or text parts, that belonged to a certain concept. They put things together that belonged together;
(2) Separating important from relatively unimportant parts. Starting - points for this were mostly 'reviews', 'summarizers' and 'synthesizers'.
(3) Establishing relationships. In many cases the reviews 'forced' them to look back in the basic text.
(4) Planning study-activities. On the basis of the structure of the text and the options subjects took decisions about what they should do first.
For example, first the complete review was studied, then the detailed textparts.
(5) Imprinting. This happened by repetion of the subjectmatter and it was especially done with the summarizers and reviews.
The most striking difference between both conditions was that in the L.C.-condition more frequent and better structuring and integration on the basis of the added instructional aids took place.
The major results from the self-report questionnaire were:
- the L.C. condition was using more prior knowledge. (L.C.: 75%, - P.C.:33%)
- students in the L.C.-condition uses more elaborations ('saying in one'n own words) and drew more conclusions (L.C.:66,7% and 56%; P.C.: 33,3%)

- the L.C.-condition showed more synthesizing activities and less study-activities as making notes.

In both conditions the options were clear, useful and necessary. What are the explanations for these results in this study? And: What can we learn for our future research. We found a little effect in favour of the L.C.-condition, mostly in the retentiontest, however we believe with Reigeluth (1983) that the ETI is likely to be valid only for instruction on a fairly large amount of subject matter (5-10 hours). In our study 'learner control' had a limited function and it concerned with the selection of textparts and text aids. The student was rather passive in stead of active and constructive.
When students provide for their own learning activities (making schemata, summarizers, reviews and synthysizers by themselves) acquisition and retaining information will be more effective (Jonassen, 1985). Student - provided - activities are necessary for studying text.
We registrated students by video-taping while studying the text. That is one possibility but it was difficult to analyse **exactly** all the study activities (time-registration, changes between text and options, the sequence etc.). In our future research we will use a Computer-Based-System for registrating and scoring the study-activities immediately (see Reigeluth & Garfield, 1984; Park & Tennyson, 1985).

SOME CONCLUDING REMARKS

The better the structure of the text, the more likely the reader is to remember the information and to engage in the higher level cognitive processes. The better organized the text, the more highly integrated the memory representation is likely to be. Highly integrated memory representations enable learners to consider related facts simultaneously, a necessary condition for higher order cognitive processes such as inferences, summarizing, decision making, and synthesizing. The manner in which various individuals utilize learning strategies over long periods of time, should influence the design of a learning - strategy. Learning strategy systems are intended to enable learners to make the most effecient use of their available resources to acquire,

retain, and utilize information.

However, the amount of training in the use of learner control to optimize performance has not been adequately investigated. But there is an important progress in the areas of learning strategies, instructional design, computer-based instruction, meta-cognition etc.

Instructional theory and technology is still alive!

FOOTNOTES

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Request for reprints - and also for the revised and more elaborated paper and a list of other publications - should be sent to Gijsbertus Beukhof, Twente University of Technology, Department of Education, Division of Instructional Technology, P.O. Box 217, 7500 AE Enschede, The Netherlands.

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TABLE 1

Means and standard deviations in experiment 1

		experimental group (n = 61)		control group (n = 59)	
		M	SD	M	SD
posttest	- multiple choice	6,885	1,233	6,014	1,025
	- essay	6,490	1,361	6,095	1,450
retention test	- multiple choice	6,325	1,148	5,066	1,047
	- essay	4,508	1,477	3,925	1,282

Note : maximum correct scores on posttest and retentiontest = 10.

TABLE 2A

Experiment 2 : means and standard deviations on the posttest: multiple choice

Sequence	Synthesizer before/after instruction		Format of the synthesizer: verbal	visual graphic	verbal + visual/ graphic	no synthesizer
General to detailed	before	M	5,65	6,10	5,77	M 6,15
		SD	1,40	1,64	1,89	SD 1,65
		N	26	29	27	N 33
	after	M	5,95	6,28	6,04	
		SD	1,98	2,00	1,91	
		N	30	25	26	
Detailed to general	before	M	5,90	6,34	5,92	M 5,80
		SD	2,04	2,18	1,76	SD 1,75
		N	30	31	24	N 33
	after	M	5,77	5,93	6,40	
		SD	1,35	1,48	2,09	
		N	24	30	25	
TOTAL:		M	5,83	6,16	6,03	
		SD	1,73	1,83	1,90	

TABLE 2B

Experiment 2 : means and standard deviations on the posttest: essay questions

Sequence	Synthesizer before/after instruction		Format of the synthesizer: verbal	visual graphic	verbal + visual/ graphic	no synthesizer
General to detailed	before	M	6,54	7,75	7,33	M 6,12
		SD	3,68	4,48	4,72	SD 3,68
		N	26	29	27	N 33
	after	M	6,23	6,40	7,50	
		SD	3,21	3,23	4,04	
		N	30	25	26	
Detailed to general	before	M	6,80	6,77	5,91	M 5,45
		SD	4,05	4,17	3,66	SD 2,87
		N	30	31	24	N 33
	after	M	6,20	6,70	6,68	
		SD	2,73	3,42	4,99	
		N	24	30	25	
TOTAL:		M	6,45	6,92	6,88	
		SD	3,44	3,86	4,37	

TABLE 2C

Experiment 2: means and standard deviations on the retentiontest: m.c.

Sequence	Synthesizer before/after instruction		Format of the synthesizer: verbal	visual graphic	verbal + visual/ graphic	no synthesizer
General to detailed	before	M	4,37	4,81	4,46	M 5,05
		SD	1,54	1,47	1,79	SD 1,46
		N	26	29	27	N 33
	after	M	4,82	5,10	5,02	
		SD	1,66	1,92	1,73	
		N	30	25	26	
Detailed to general	before	M	4,76	4,95	4,75	M 4,47
		SD	2,15	1,73	1,81	SD 1,58
		N	30	31	24	N 33
	after	M	4,00	4,58	4,90	
		SD	1,72	1,39	1,49	
		N	24	30	25	
TOTAL:		M	4,52	4,85	4,78	
		SD	1,80	1,62	1,70	

TABLE 2D

Experiment 2: means and standard deviations on the retentiontest : essay

Sequence	Synthesizer before/after instruction		Format of the synthesizer: verbal	visual graphic	verbal + visual/ graphic	no synthesizer
General to detailed	before	M	5,27	5,38	5,29	M 4,64
		SD	3,31	3,40	3,92	SD 2,95
		N	26	29	27	N 33
	after	M	4,72	5,40	6,19	
		SD	3,17	3,07	3,67	
		N	30	25	26	
Detailed to general	before	M	5,00	5,52	5,16	M 4,42
		SD	3,73	3,88	3,34	SD 2,69
		N	30	31	24	N 33
	after	M	4,13	5,27	5,88	
		SD	2,01	3,17	4,73	
		N	24	30	25	
TOTAL :		M	4,80	5,39	5,64	
		SD	3,15	3,37	3,92	

TABLE 3

Experiment 3: means and standard deviations

		LEARNER CONTROL N=12	PROGRAM CONTROL N=12	T-testing a: .05 df: 22
POSTTEST				
- multiple choice	M	10,58	10,50	t=.15 p=.88
	SD	1,44	1,24	n.s.
- essay questions	M	33,00	34,50	t=.93 p=.36
	SD	4,22	3,68	n.s.
RETENTIONTEST				
- multiple choice	M	8,25	7,25	t=1,72 p=.10
	SD	1,60	1,22	n.s.
- essay questions	M	28,92	26,83	t=1,38 p=.18
	SD	4,03	3,33	n.s.
NOTES				
- amount of concepts	M	20,92	51,00	t=2,27 p=.03
	SD	27,64	36,76	s.
- amount of relations between concepts	M	9,83	32,42	t=2,63 p=.02
	SD	12,66	26,97	s.
TIME FOR OPTIONS (in minutes)				
- total	M	19,97	14,88	t=1,81 p=.08
	SD	6,90	6,87	n.s.
- epitome	M	4,62	0,78	t=7,67 p=.00
	SD	1,59	0,70	s.
- synthesizer	M	0,92	1,29	t=.99 p=.33
	SD	0,53	1,15	n.s.
- review	M	9,10	10,55	t=.79 p=.43
	SD	3,30	5,46	n.s.
- summarizer	M	4,12	2,57	t=.1,74 p=.10
	SD	2,61	1,62	n.s.